

04/16/98
i:586 U.S. PTO

A

PATENT

ATTORNEY DOCKET N^o: 38292R1
EXPRESS MAIL LABEL N^o: EL 025 200 855 US

NONPROVISIONAL PATENT APPLICATION TRANSMITTAL LETTER

BOX PATENT APPLICATION
ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON DC 20231

Transmitted herewith for filing is the patent application of:

INVENTOR(S): LEO JOHN WILZ
1718 Hamer Drive, N.W.
Cedar Rapids, IA 52405
Linn County
Citizen of the United States

Title: **IMPROVED RECEIVER SENSITIVITY FOR TRANSCEIVER
HAVING DIVERSITY ARCHITECTURE**

CERTIFICATION UNDER 37 C.F.R. §1.10

I hereby certify that this Nonprovisional Application Transmittal and the documents referred to as enclosed therein are being deposited with the United States Postal Service on this date, April 16, 1998 in an envelope as "Express Mail Post Office to Addressee", Mailing Label N^o EL 025 200 855 US addressed to: Box Patent Application, Assistant Commissioner for Patents, US PTO, Washington, D.C. 20231.

Lora Frecks

Lora M. Frecks

DATED: April 16, 1998

**CLAIM FOR BENEFIT OF EARLIER
APPLICATIONS UNDER 35 U.S.C. § 119(e)**

USSN
60/044,249

Filing Date
04/23/97

Inventor(s)
Wilz

Status
Provisional

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383	2384	2385	2386	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400	2401	2402	2403	2404	2405	2406	2407	2408	2409	2410	2411	2412	2413	2414	2415	2416	2417	2418	2419	2420	2421	2422	2423	2424	2425	2426	2427	2428	2429	2430	2431	2432	2
--	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	---

Eighteen (18) Pages of Specification;
Four (4) Pages of Claims;
One (1) Page of Abstract; and
Seven (7) Sheets of Drawing Figures.

BASIC FILING FEE					\$790.00
EXCESS CLAIM FEE					
TOTAL OVER TWENTY	0	x	\$22.00		
INDEPENDENT OVER THREE	0	x	\$82.00		
MULTIPLE DEPENDENT CLAIMS	0	x	\$270.00		

TOTAL FILING FEES					<u>\$790.00</u>

This and the Surcharge Required by 37 C.F.R. §1.16(e) May Be Paid Subsequently.

Please direct all correspondence to:

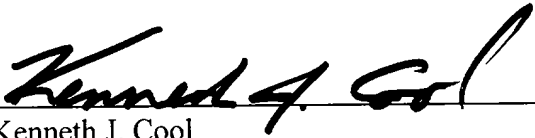
SEAN PATRICK SUITER
SUITER & ASSOCIATES, PC
11516 Nicholas Street, Suite 205
Omaha, NE 68154-4409
(402) 496-0300 (Telephone)
(402) 496-0333 (Facsimile)

DATED: April 16, 1998.

Respectfully submitted,

Leo John Wilz,

INTERMEC TECHNOLOGIES CORP.,

By 
Kenneth J. Cool
Reg. N° 40,570

END OF DOCUMENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR PATENT

ON

IMPROVED RECEIVER SENSITIVITY FOR TRANSCEIVER HAVING
DIVERSITY ARCHITECTURE

IMPROVED RECEIVER SENSITIVITY FOR TRANSCEIVER HAVING DIVERSITY ARCHITECTURE

5

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims the benefit under 35 U.S.C. § 119(e) to provisional application Serial No. 60/044,249 filed April 23, 1997. Said provisional application Serial No. 60/044,249 is hereby incorporated by reference in its entirety.

10

BACKGROUND OF THE INVENTION

The present invention generally relates to the field of wireless communications, and more particularly to a transceiver having improved receiver architecture.

15

There are many applications in which it is desirable to be able to provide wireless communications. For example, in an industrial warehouse environment individual roaming workers may utilize portable data terminals for inventory tracking and accounting purposes. The warehouse worker must be mobile, having the freedom of movement throughout any position in the warehouse to reach the product location, yet remain in constant communication with a central or host computer over a local network. In such an application, it is desirable for the mobile data terminal to communicate with the host computer over the central network via wireless communications, for example by using a radio-frequency transceiver. Thus, an interface device, or access point, may be utilized to serve as an interface between a wireless and a directly linked communication network.

20

25

It is often desirable for a network interface device to utilize several forms of communications media. For example, it may be desirable to

provide an access point interface to utilize two individual radio-frequency transceivers for providing communications at two different frequencies simultaneously. Such a transceiver may transmit on a first frequency and receive on a second frequency in order to provide full duplex communications, avoid interference, etc.

A communication transceiver typically requires or preferably utilizes duplex communications wherein information is both transmitted and received by a single unit transceiver unit and wherein the transmitter apparatus and receiver apparatus of the transceiver share common hardware and resources. In such a transceiver, selection between the transmitter and receiver is implemented via switching and electronic enabling of the required hardware devices. However, because of the loading and cross talk effects caused by the sharing of common hardware and from the use of switches, increased noise may be introduced into the communication signal, the signal-to-noise ratio may decreased and the noise figure of the signal may be increased correspondingly. Lower signal-to-noise ratios adversely affect maximum transmission ranges and increased noise figures result in an increase in transmission error rates because of maximum power limits mandated by government regulations and other design constraints.

SUMMARY OF THE INVENTION

Accordingly, it is a goal of this invention to provide a method and apparatus for improving the signal-to-noise ratio and reducing the noise figure of a wireless communications transceiver which utilizes dual transceiver and receiver architecture wherein multiple or diversity architecture may be utilized.

The transceiver architecture of the present invention may be utilized in a base station transceiver or a mobile transceiver unit of a

mobile radio data communication system, or in similar devices and systems, as disclosed in U.S. Patent No. 5,483,767 issued January 9, 1996, said U.S. patent being assigned to the entity to whom the present invention and application are subject to obligation of assignment. Said
5 U.S. Patent No. 5,483,767 is hereby incorporated by reference herein in its entirety.

The transceiver architecture of the present invention may be utilized in a data transceiver module for digital communications such as a spread spectrum transceiver module utilizing multiple mode
10 transmission as disclosed in PCT Publication No. WO 96/38925 published December 5, 1996, said PCT publication being assigned to the entity to whom the present invention and application are subject to obligation of assignment.

It is to be understood that both the foregoing general description
15 and the following detailed description are exemplary and explanatory only and are not restrictive of the invention as claimed.

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate an embodiment of the invention and together with the general description, serve to explain the
20 principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The numerous objects and advantages of the present invention may be better understood by those skilled in the art by reference to the
25 accompanying figures in which:

FIG. 1 is an illustration of a multilevel communications system in accordance with the present invention;

FIG. 2 is an illustration of a communications system of the present invention, further showing a hybrid wireless and direct link communications system;

FIG. 3 is an illustration of a network access node of a communications system in accordance of the present invention, further showing the implementation of dual wireless communications transceivers;

FIG. 4 is an illustration of an alternative configuration of the communication system of FIG. 3;

FIG. 5 is an illustration of a communication system of the present invention, further showing a diversity architecture transceiver;

FIG. 6 is an illustration of standard architecture for implementing a diversity architecture transceiver in accordance with the present invention;

FIG. 7 is an illustration of improved architecture for implementing a diversity architecture transceiver in accordance with the present invention;

FIG. 8 is an illustration of an alternative transceiver architecture of the present invention having improved receiver sensitivity and interference rejection; and

FIG. 9 is an illustration of multiple access points utilizing communication transceivers of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made in detail to the presently preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings.

Referring now to FIG. 1, a multilevel communications system in accordance with the present invention is shown. The multileveled

communication system **10** typically comprises a central host computer ("HOST COMPUTER") **12** functioning as a main sever for performing computationally intensive and time consuming processing tasks, centralized mass storage functions, network management and control tasks and the like, etc. The central host computer **12** may be any of a variety of commercially available central computers or servers, for example a VAX mainframe or Alpha Server available from Digital Corporation, an AS/400, RS/6000 or S/390 server available from IBM Corporation, or the like kind of server. The central computer **12** hosts, implements and controls a centralized local network ("NETWORK") **14** for providing a linkage between several communication channels. A plurality of network access points ("ACCESS POINT") **16**, **18** and **20** may be connected to the network **14**, each providing an access node to the host computer **10** through the network **14**.

Each of the network access points may be capable of functioning as a point of access for individual computer terminals ("TERMINAL"). For example, access point **16** may provide network interfacing functions for terminals **22**, **24** and **26**; access point **18** may provide network interfacing functions for terminals **28**, **30** and **32**; and access point **20** may provide network interfacing functions for terminals **34**, **36** and **38**.

The network **14** as illustrated in FIG. 1 and as referred to herein preferably refers to any type of widely utilized local area network (LAN) and may be equally applicable to any type of widely utilized wide area network (WAN). Such network may be, for example, a type of network referred to as "Ethernet" which operates according to standards promulgated by the Institute of Electrical and Electronics Engineers (IEEE) such as any IEEE 802.3 standard. Further, any IEEE promulgated network standard may be utilized. For example, the network **14** may be a commonly utilized 10Base-T, 10Base-2 or 10Base-

5 Ethernet having data transmission rates on the order of 10 megabits per second (10-Mbps). Alternatively, the network **14** may be a Fast Ethernet, or 100Base-T, network having data transmission rates on the order of 100 megabits per second (100-Mbps). The network **14** may
5 preferably be a Gigabit Ethernet network having data transmission rates on the order of one gigabit per second (1-Gbps) according to the Gigabit Ethernet Standard IEEE 802.3z as the standard becomes widely utilized. The network may further implement other types of available network protocols or standards as well, such as the CSMA/CD protocol, Token
10 Ring, FDDI, ATM, Fibre Channel, and other common network protocols, for example.

The network **14** may be compatible with widely utilized operating systems and applications, including upper layer protocol stacks such as TCP/IP, IPX, Netbui, DECnet, and others, for example. Other emerging
15 new network standards may be utilized with network **14** as well, such as IEEE 802.1q or IEEE 802.1p for providing VLAN and explicit priority information for packets in the network. Further, other advanced signal processing techniques may be incorporated with the network **14** such as data compression to improve the effective bandwidth over the bandwidth
20 fixed by physical limitations, for example MPEG-2 compression. Full-duplex operating modes for switch-to-switch and switch-to-end station connections are supported by network **14**, including support for half-duplex operating modes if necessary for shared connections, such as when using repeaters or the CSMA/CD access method. The network **14**
25 preferably utilizes fiber optic hardwire direct connections, but may also support Category 5 unshielded twisted-pair (UTP) or coaxial transmission lines.

Referring now to FIG. 2, a communications system of the present invention is shown, illustrating a hybrid wireless and direct link

communications system. The communications system **40** may utilize a central host computer ("HOST") **42** and network ("NETWORK") **44** substantially similar to the host computer **12** and network **14** of FIG. 1. One or more access points may be utilized to provide multiple modes of access to the computer network **44**. Access points or servers ("WIRELESS-DIRECT LINK") **46**, **48** and **50** may provide an interface between a wired communications system **70** and a wireless communications system **72**. Each of the access points **46**, **48** and **50** for providing a wireless-to-direct system link may utilize a transceiver having diversity architecture in accordance with the present invention for communicating with mobile data terminals ("MOBILE TERMINAL") **52** and **54** which may be similarly equipped. Mobile terminals **52** and **54** may communicate over the network **44** by linking to the network through access points **46**, **48** and **50** via communication links **74**, **76**, **78** and **80**. Communication links **74**, **76**, **78** and **80** are preferably radio-frequency communication links. The overall effective roaming range of the mobile terminals **52** and **54** may be extended by utilization of an intermediate access point ("WIRELESS-WIRELESS LINK") **56** which provides a wireless-to-wireless communications link to the network **44**. The mobile terminals **52** and **54** may communicate with the intermediate access point **56** via wireless communication links **82** and **84**, respectively, which in turn communicates with a wireless-to-direct access point **48** via wireless communication link **86**, which in turn directly communicates over the network **44**.

The access points are preferably NORAND 6710 access points available from NORAND Corporation of Cedar Rapids, Iowa. The access points preferably operate with AMD 29200 RISC processors to implement a real-time multitasking operating system for servicing the radio, or wireless, network and the direct connection network (e.g., Ethernet). The

access points may be managed by Simple Network Management Protocol (SNMP) version one (SNMPv1) or version two (SNMPv2) or the Common Management Information Protocol (CMIP) to allow configuration and access to network configurations such as the NORAND Enterprise Management Information Base. The access points may further include two PC Card (a.k.a. PCMCIA) version 2.0 or higher slots for accommodating Type II or Type III PC cards. The access points are preferably compatible with WLI Forum compatible devices. Structurally, the access points may comprise a housing meeting the NEMA Standard ICS-110, for example NEMA 4 which is watertight and dust-tight for indoor applications for protecting the access point equipment against splashing water, water seepage, falling water, hose-directed water and severe external water condensation. Alternatively, the housing of the access point may comprise an Intrinsically-Safe enclosure.

Mobile terminal **52** may be temporarily stationed in a terminal dock ("TERMINAL DOCK") **58** which may be directly linked to network **44**, for example to provide batch type data transfer when not in use or when the wireless system **72** is shut down or not available. Further, mobile terminal **52** may be docked in terminal dock **64** so that the terminal may operate and communicate with peripheral device ("PERIPHERAL DEVICE") **62**. Peripheral device **62** may be a printer, an independent computer, a battery charging power source, a vehicle, a workstation, etc. Additionally, terminal dock **64** and peripheral device **62** may be incorporated into a single physical unit such as a mobile printer having a terminal receiving receptacle and appropriate communications facilities. A peripheral device **66** similar to peripheral device **62** may be connected to intermediate access point **56** wherein mobile terminal **54** operates and communicates with peripheral device **66** via communication link **84**.

Mobile terminal **54** may operate and communicate with peripheral device **68** via communication link **88**. Peripheral device **68** may be a device similar to peripheral devices **62** and **66**. Further, communication link **88** may one of several differing types of wireless links. For example, wireless link **88** may utilize infrared communications for providing a low power, short hop communication link. Alternatively, communication link **88** may be an optical link, or may be a radio-frequency link. Further, any of the wireless communications links **74**, **76**, **78**, **80**, **82**, **84**, **86** or **88** may implement one or more types of remote communications such as infrared, optical, radio-frequency, sonic, ultrasonic, magnetic, etc.

The wired communications system **70** and the wireless communications system **72** may utilize the NORAND Open Wireless LAN Network Management Application for providing network management functions. The network management platform may further incorporate HP OpenView for WINDOWS and NodeManager for HP-UX available from Hewlett-Packard Corporation (WINDOWS being a trademark of Microsoft Corporation).

Referring now to FIG. 3, a network access node of a communications system in accordance with the present invention is shown, illustrating the utilization of dual wireless communications transceivers. The communications system **90** of FIG. 3 may comprise a direct link communications system **120** and a wireless link communications system **122**. The direct link communications system **120** may include a central host computer ("HOST") **92** implementing a computer network ("NETWORK") **94** substantially similar to networks **14** and **44** shown in FIGS. 1 and 2. Access point **96** communicates directly with the network **94** and may invariably utilize controller ("CONTROLLER") **98** for implementing the network interfacing functions. The access point **96** may also include dual transceivers

(“TRANSCIVER”) **100** and **102** being ultimately connected to controller **98**. The transceivers **100** and **102** may utilize wireless communications for operating over communications links **116** and **118**. Transceivers **100** and **102** may utilize antennas **104** and **106**, respectively, in the case
5 where communications links **116** and **118** are radio-frequency communications links. In such a case, mobile terminals (“TERMINAL”) **108** and **110** utilize antennas **112** and **114**, respectively and of like kind, for radio-frequency communications over communications links **116** and **118**.

10 Dual transceivers **100** and **102** may be utilized in a single access point **96** for varying purposes. For example, a first transceiver **100** may be utilized to communicate with the network at a first level of security and access in which only terminal **108** is allowed to communicate with transceiver **100**. The operator of terminal **108** may have a higher level of
15 access to the network **94** for performing administrative, supervisory, accounting, or programming type activities which may not be available to all terminal operators and which may be accessible only through transceiver **100** via link **116**. The operator of terminal **110** may be provided with a lower level of access to network **94** and therefore may
20 communicate only with transceiver **102** via link **118**. Alternatively, multiple transceivers operating at different frequencies may be utilized in a single access point **96** to increase the number of usable channels and therefore the number of terminals operating in a single location. For example, transceiver **100** may accommodate up to 24 terminals and
25 transceiver **102** may accommodate an additional 24 terminals for allowing the operation of a total of 48 terminals on the communication system **90**.

The transceivers of FIG. 3 may operate on available frequencies unregulated or made widely available for commercial use by government

agencies. For example, transceiver **100** may be a 2.4 GHz RangeLAN2 radio while transceiver **102** may be a Norand 900 MHz radio wherein both radios may be utilized simultaneously. The transceivers **100** and **102** may be PC card (a.k.a. PCMCIA) form factor radio cards conforming to PC Card standard version 2.0 or higher, for example. The transceivers **100** and **102** may be either WLI Forum or IEEE 802.11 compatible radios.

Referring now to FIG. 4, an alternative configuration of the communication system of FIG. 3 is shown. The network **124** may comprise a host computer ("HOST") **126** implementing a computer network ("NETWORK") **128**. An access point **130** may communicate with the direct link communications system **160** via a controller ("CONTROLLER") **132** operationally connected to the network **128**. The access point **130** utilizes a transmitter ("TRANSMITTER") **134** and a receiver ("RECEIVER") **136**, which are ultimately connected to controller **132** for communicating over wireless communications system **158**. The transmitter **134** may be a dedicated transmitter for performing communications transmissions to mobile terminals ("TERMINAL") **142** and **144** via communications links **150** and **152**. Conversely, receiver **136** may be a dedicated receiver for receiving data communications from mobile terminals **142** and **144** via communications links **154** and **156**. In the instance in which communications links **150**, **152**, **154** and **156** are radio-frequency links, antennas **138**, **140**, **146** and **148** may be utilized by transmitter **134**, receiver **136**, terminal **142** and terminal **148** respectively.

Access point **130** may utilize a dedicated transmitter **134** and a dedicated receiver **136** for varying purposes. For example, the hardware of the transceiver **134** may be optimized for data transmissions whereas the hardware of the receiver **136** may be optimized for data receptions,

which may require different hardware designs. Other inherent advantages may be further realized. For example, isolation of the output stages of the transmitter **134** from the input stages of the receiver **136** will prevent noise in the output of the transmitter **134** from being introduced onto the received communications signal and inadvertently amplified by the input stages of the receiver **136**. Additionally, full duplex transmissions and true multitasking operations may be implemented such that access point **130** may simultaneously upload and download data to terminals **142** and **144**.

Referring now to FIG. 5, a communication system of the present invention is shown utilizing a transceiver having diversity architecture. The communications system **162** may comprise a host computer ("HOST") **164** implementing a computer network ("NETWORK") **166**. Access point **168** communicates with the network via controller **170** via direct link communications system **188**. Access point **168** utilizes a diversity architecture transceiver **172** in accordance with the present invention, the diversity architecture transceiver being ultimately connected to controller ("CONTROLLER") **170**. The diversity architecture transceiver ("TRANSCEIVER") **172** may utilize two antennas **174** and **176** which may be integrated as a dual antenna. The diversity architecture transceiver **172** communicates with mobile terminal ("TERMINAL") **178** via wireless communications links **182** and **184** wherein terminal **178** utilizes an antenna **180** of like kind to antennas **174** and **176** when communications links **182** and **184** are radio-frequency communications links. Access point **168** may utilize one or more diversity architecture transceivers **172** for any one or more varying purposes, including reasons set forth in the description to FIGS. 1-4.

Referring now to FIG. 6, standard architecture is shown for implementing a transceiver having diversity architecture. The standard

transceiver **190** may utilize first and second antennas **192** and **194** being connected to a single pole, double throw (SPDT) switch **196** for selection of one antenna or the other. The switch **196** feeds into a bandpass filter **198** which in turn feeds into the transceiver hardware

5 **200**. At the input of the transceiver hardware, the bandpass filter feeds into a single pole, double throw switch **202** which is used to select between receiver front end hardware **204** and transmitter back end hardware **206**. When the switch **202** is set to select receiver hardware **204**, the output of the bandpass filter **198**, after being received by the

10 selected one of the two antennas **192** and **194** with switch **196** and after passing through bandpass filter **198**, feeds into a low noise input amplifier ("LNA") **208** which in turn feeds into mixer **210**. The mixer **210** combines received input signals with the output of a receiver local oscillator ("LO") **212** to provide a receiver data signal ("RxD") **214**. When

15 switch **202** is set to select transmitter back end hardware **206**, a transmit data signal ("TxD") **216** is combined with the output of a transmitter local oscillator **218** using mixer **220**. The output of mixer **220** feeds into a transmitter power amplifier ("PA") **222**, the output of which feeds into the selected antenna **192** or **194** via switch **196** after

20 being fed through filter **198**.

Referring now to FIG. 7, improved architecture for implementing a transceiver having diversity architecture in accordance with the present invention is shown. The diversity architecture transceiver **224** may utilize multiple antennas **226** and **228** as discussed, *supra*. A first

25 antenna **226** maybe utilized to receive a radio-frequency signal. The signal received by antenna **226** may be bandpass filtered by filter **230**, the output of which is fed into the transceiver hardware **234**. Within the transceiver hardware **234**, the output of the bandpass filter may be fed into a low noise amplifier ("LNA") **238**.

A second antenna **228** may be further utilized which is capable of being used for receiving and transmitting purposes. Antenna **228** connects to bandpass filter **232** to filter out signals lying outside of the pass band frequency range for either transmitted or received signals.

- 5 Bandpass filter **232** connects to a single pole, double throw switch **236** within the transceiver hardware **234**. Switch **236** selects between receiving functions **254** and transmitting functions to be performed using antenna **228**. When switch **236** is set to select receiving functions **254**, bandpass filter **232** feeds into a low noise amplifier ("LNA") **240**.
- 10 When switch **236** is set to select transmitting functions **256**, a transmitting power amplifier ("PA") **242** is selected for the transmitter output signal path.

- Within the transceiver hardware **234**, a single pole, triple throw switch **244** selects between receiving signals via antenna **226**, receiving
- 15 signals via antenna **228**, or transmitting signals via antenna **228**. Switch **246** connects to low pass filter **246** which in turn connects to mixer **248** for combining received signals with the output of a local oscillator **250** to produce intermediate frequency signals **252**, and vice versa for transmitted signals.

- 20 It has been discovered that the transceiver having diversity architecture of FIG. 7 provides at least a two decibel improvement in the transceiver noise figure resulting from effectively placing switch **196** of FIG. 6 after the low noise amplifiers as illustrated in FIG. 7. Further, enable signals ("EN") **258**, **260** and **262** may be provided to amplifiers
- 25 **238**, **240** and **242**, respectively, to turn off the amplifiers when not in use so as to not introduce any interfering noise in the activated amplifiers.

Referring now to FIG. 8, an alternative transceiver architecture of the present invention is shown having improved receiver sensitivity and

interference rejection. Transceiver **264** may utilize multiple antennas **266** and **268** for reasons as set forth, *supra*. A first antenna **266** may be utilized for receiving input signals and may feed directly into a low noise amplifier ("LNA") **270**. Amplifier **270** may operate in the open loop mode, or may operate in the closed loop mode as shown by feedback loop **272** in dashed lines. Switching between open loop and closed loop modes for amplifier **270** may be accomplished via a single pole, single throw (SPST) switch **274** in feedback loop **272**.

The output of amplifier **270** preferably feeds into a single pole, double throw switch **276** which may be utilized to select between the utilization of antennas **266** or **268** for signal receiving purposes. Switch **276** connects to bandpass filter **278** which in turn feeds into a low noise amplifier ("LNA") **280**. The output of amplifier **280** feeds into mixer **282** where received signals are combined with local oscillator **284** to produce intermediate frequency signals **286**.

Antenna **268** may be utilized for either receiving or transmitting signals. Antenna **268** connects to low pass filter **288** which in turn connects to a single pole, double throw switch **290**. Switch **290** may be utilized to selectively connect antenna **268** to receiver hardware **300** or transmitter hardware **302**. When switch **290** is set to select receiver hardware **300**, switch **290** connects antenna **268** through filter **288** to switch **276**. When switch **290** is set to select transmitter hardware **302**, switch **290** connects to the output of transmitter power amplifier ("PA") **292**. Power amplifier **292** receives the output of mixer **294** which combines intermediate frequency signals with the output of a transmitter local oscillator ("LO") **296**.

It has been discovered that better receiver sensitivity over the standard transceiver design, such as shown in FIG. 6, through antenna **266** may be attained by the diversity architecture of FIG. 8. Further, the

architecture of FIG. 8 provides better interference rejection of signals received with antenna **268** than with the standard transceiver design. Additionally, less power output of the power amplifier **292** of the transmitter section **302** is required since the amplifier is driving a low pass filter having a one-half decibel loss versus the three decibel loss of the bandpass filter **198** of the standard design. Further, each amplifier **270**, **280** and **292** may be selectively activated with enable signals **304**, **306** or **308**, respectively, such that noise will not be inadvertently interfere with the activated amplifier or amplifiers.

Referring now to FIG. 9, multiple access points utilizing communication transceivers of the present invention are shown. In FIG. 9, a wireless communication operation **310** between dual access points **312** and **314** is shown. Such an operation **310** maybe substantially similar to communications between access points **48** and **56** of FIG. 2 showing a wireless communications link **86** between the two access points. **R1** may represent one-half of the maximum operating distance between two given access points utilizing standard architecture transceivers such as shown in FIG. 6. Thus, radius **R1** may be considered to represent the given operating radius attributed to an individual access point for a standard architecture transceiver. Radius **R2** may be considered to represent the given operating radius attributed to an individual access point when a transceiver having the diversity architecture of the present invention, such as transceiver **224** of FIG. 7 or transceiver **264** of FIG. 8.

As illustrated in FIG. 9, access points **312** and **314** may be set apart a given distance wherein the operating radii **R1** of the access points do not overlap when utilizing standard transceiver architecture, and no wireless communications between access points **312** and **314** may occur. However, because the operating radii **R2** of the access points

do overlap at the distance depicted in FIG. 9, wireless communications between access points **312** and **314** may occur. Thus, as illustrated, the improved transceiver architecture of the present invention provides for an increased operational range of the transceivers for a given maximum
5 broadcasting power. Maximum broadcasting powers are typically mandated by governmental agencies, therefore the capability of increasing operational range of wireless communications without increasing broadcasting power is highly advantageous.

It is believed that the improved receiver sensitivity for a diversity
10 architecture transceiver of the present invention and many of its attendant advantages will be understood by the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the components thereof without departing from the scope and spirit of the invention or without sacrificing
15 all of its material advantages. The form herein before described being merely an explanatory embodiment thereof. It is the intention of the following claims to encompass and include such changes.

CLAIMS

What is claimed is:

1 1. A communications transceiver, comprising:
2 a first antenna connected to a first amplifier;
3 a second antenna connected to a second amplifier;
4 an intermediate frequency stage; and
5 a selector being connected between said first and second amplifiers
6 and said intermediate frequency stage for selecting operation of the
7 communications transceiver between said first and second antennas.

1 2. A communications transceiver as claimed in claim 1,
2 wherein said first amplifier is an input amplifier for amplifying signals
3 received by said first antenna.

1 3. A communications transceiver as claimed in claim 1,
2 wherein second amplifier is an input amplifier for amplifying signals
3 received by said second antenna.

1 4. A communications transceiver as claimed in claim 1,
2 wherein said second amplifier is an output amplifier for amplifying
3 signals transmitted by said second antenna.

1 5. A communications transceiver as claimed in claim 4, further
2 comprising a third amplifier connected to said second antenna and said
3 selector for amplifying signals received by said second antenna.

1 6. A communications transceiver as claimed in claim 5, further
2 comprising a second selector connected between said second antenna
3 and said second and third amplifiers for selecting connection of said
4 second antenna between said second and third amplifiers.

1 7. A communications transceiver as claimed in claim 1, further
2 comprising a filter disposed between said selector and said intermediate
3 frequency stage.

1 8. A communications transceiver as claimed in claim 7,
2 wherein said filter is a low-pass filter.

1 9. A communications transceiver as claimed in claim 1, further
2 comprising a filter disposed between said first antenna and said first
3 amplifier.

1 10. A communications transceiver as claimed in claim 9,
2 wherein said filter is a bandpass filter.

1 11. A communications transceiver as claimed in claim 1, further
2 comprising a filter disposed between said second antenna and said
3 second amplifier.

1 12. A communications transceiver as claimed in claim 11,
2 wherein said filter is a bandpass filter.

1 13. A communications transceiver as claimed in claim 6, further
2 comprising a filter disposed between said second antenna and said
3 second selector.

1 14. A communications transceiver as claimed in claim 1, said
2 first amplifier including an enable control for selectively activating said
3 first amplifier.

1 15. A communications transceiver as claimed in claim 1, said
2 second amplifier including an enable control for selectively activating
3 said second amplifier.

1 16. A communications transceiver as claimed in claim 5, said
2 third amplifier including an enable control for selectively activating said
3 third amplifier.

38292R1

1 17. A communications transceiver, comprising:
2 a first antenna connected to a first amplifier;
3 a second antenna;
4 an intermediate frequency stage connected to a second amplifier;
5 and
6 a selector disposed between said first amplifier and said
7 intermediate frequency stage and between said second antenna and said
8 second amplifier for selecting operation of the communications
9 transceiver between said first and second antennas.

1 18. A communications transceiver as claimed in claim 17,
2 wherein said first amplifier includes a feedback loop for altering the
3 operational characteristics of said first amplifier.

1 19. A communications transceiver as claimed in claim 18,
2 wherein said feedback loop includes a switch for selectively activating
3 said feedback loop.

1 20. A communications transceiver as claimed in claim 18,
2 wherein said feedback loop is a closed loop.

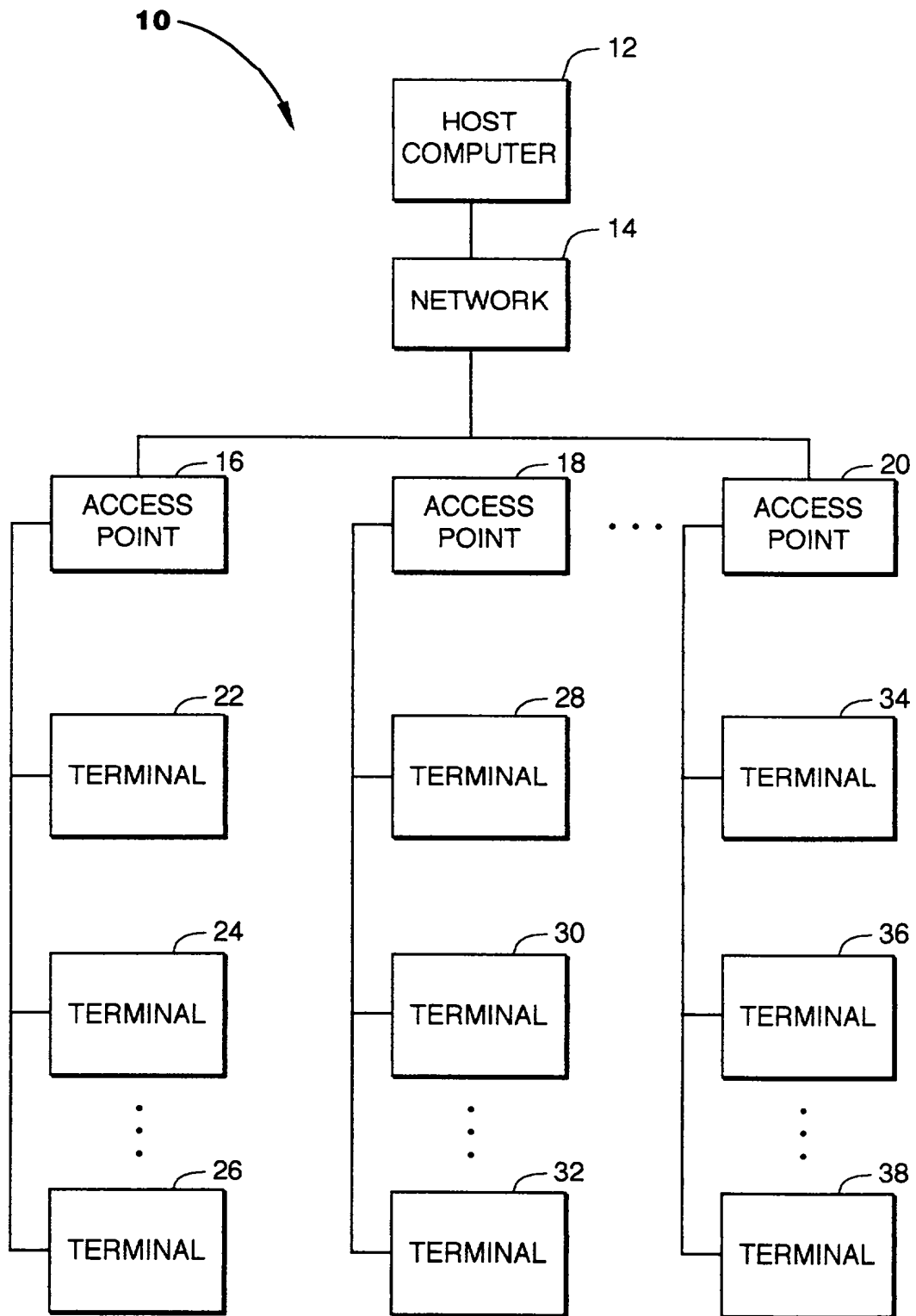


FIG. 1

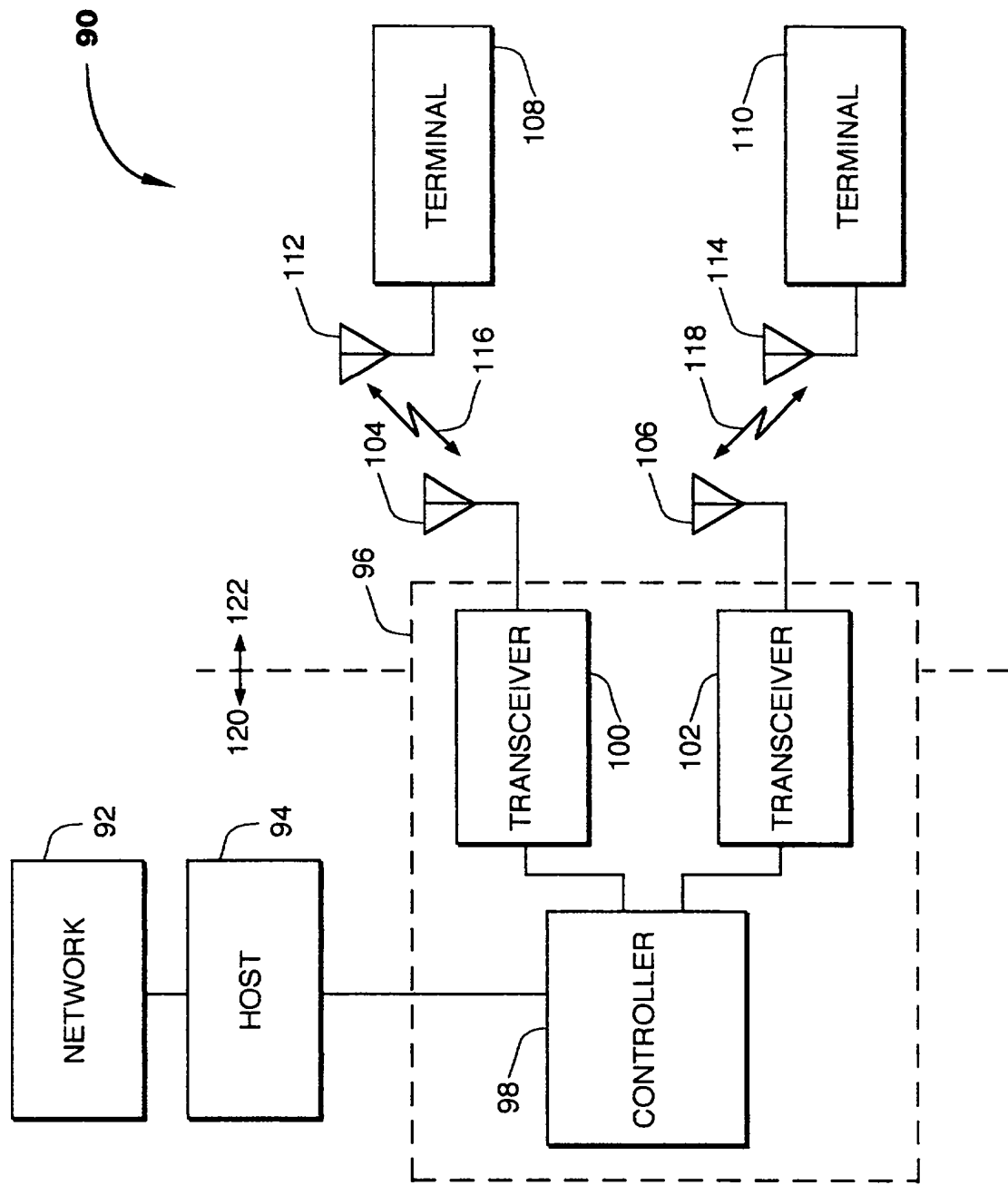


FIG. 3

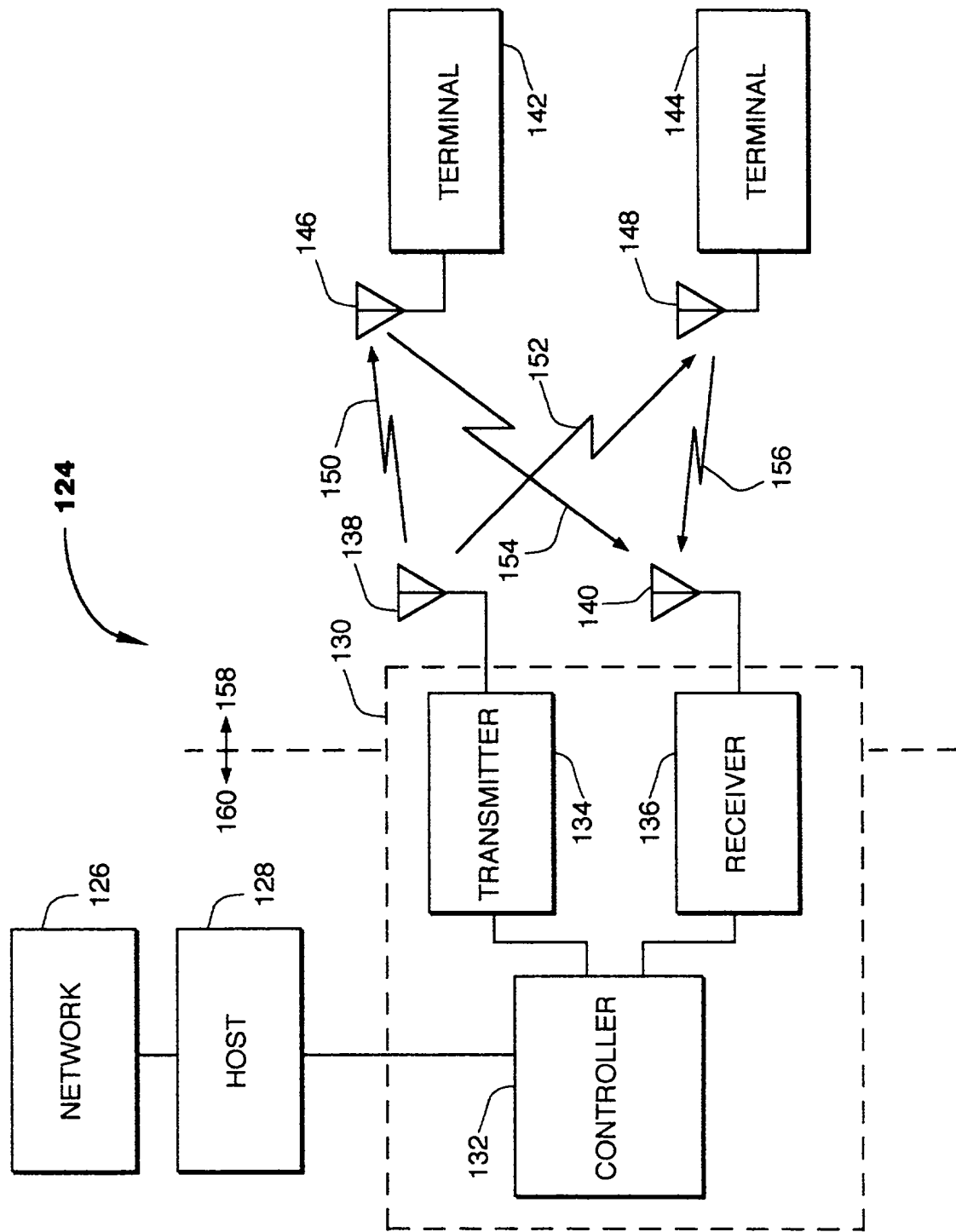


FIG. 4

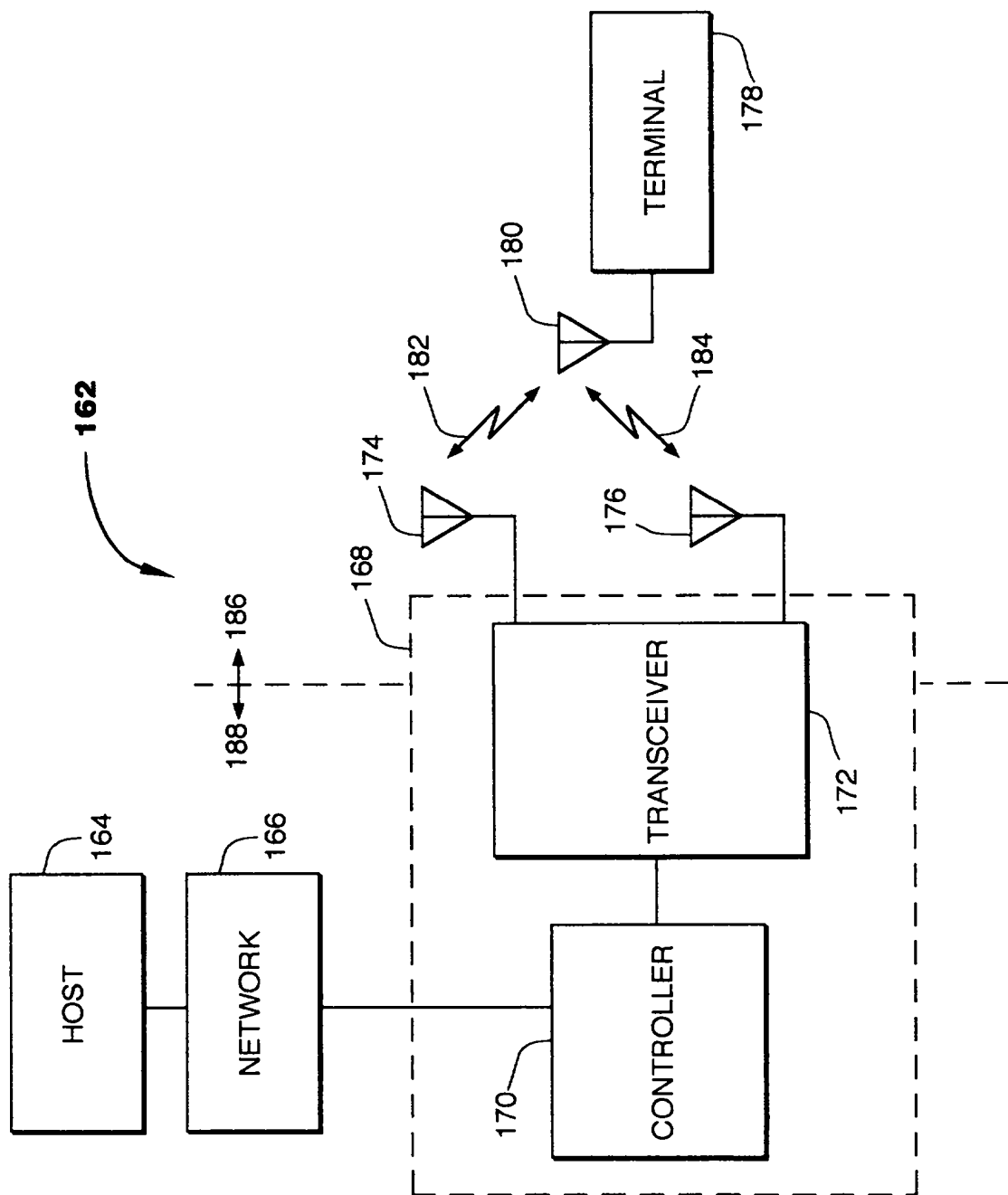


FIG. 5

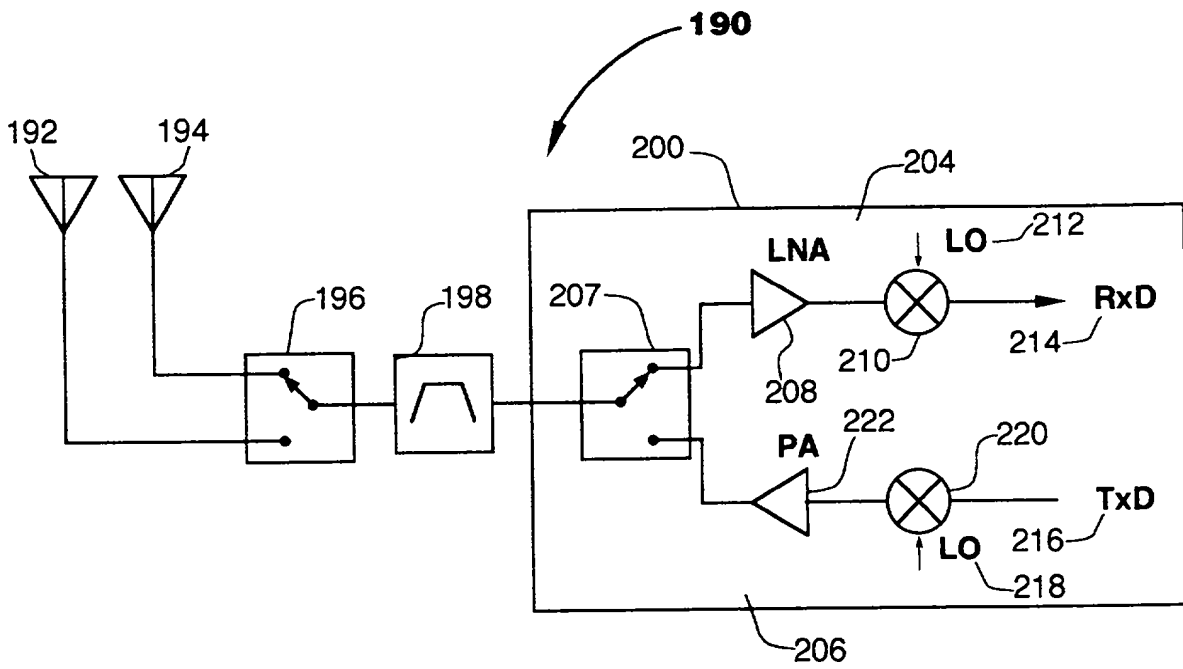


FIG. 6

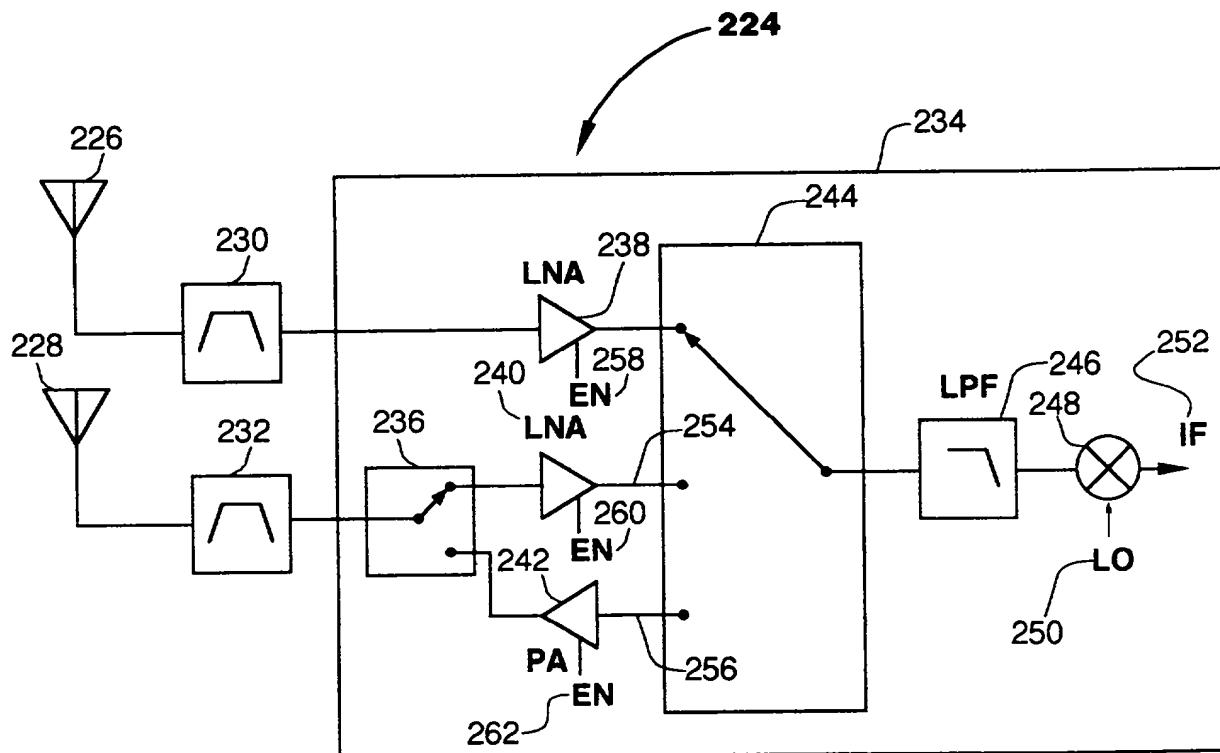
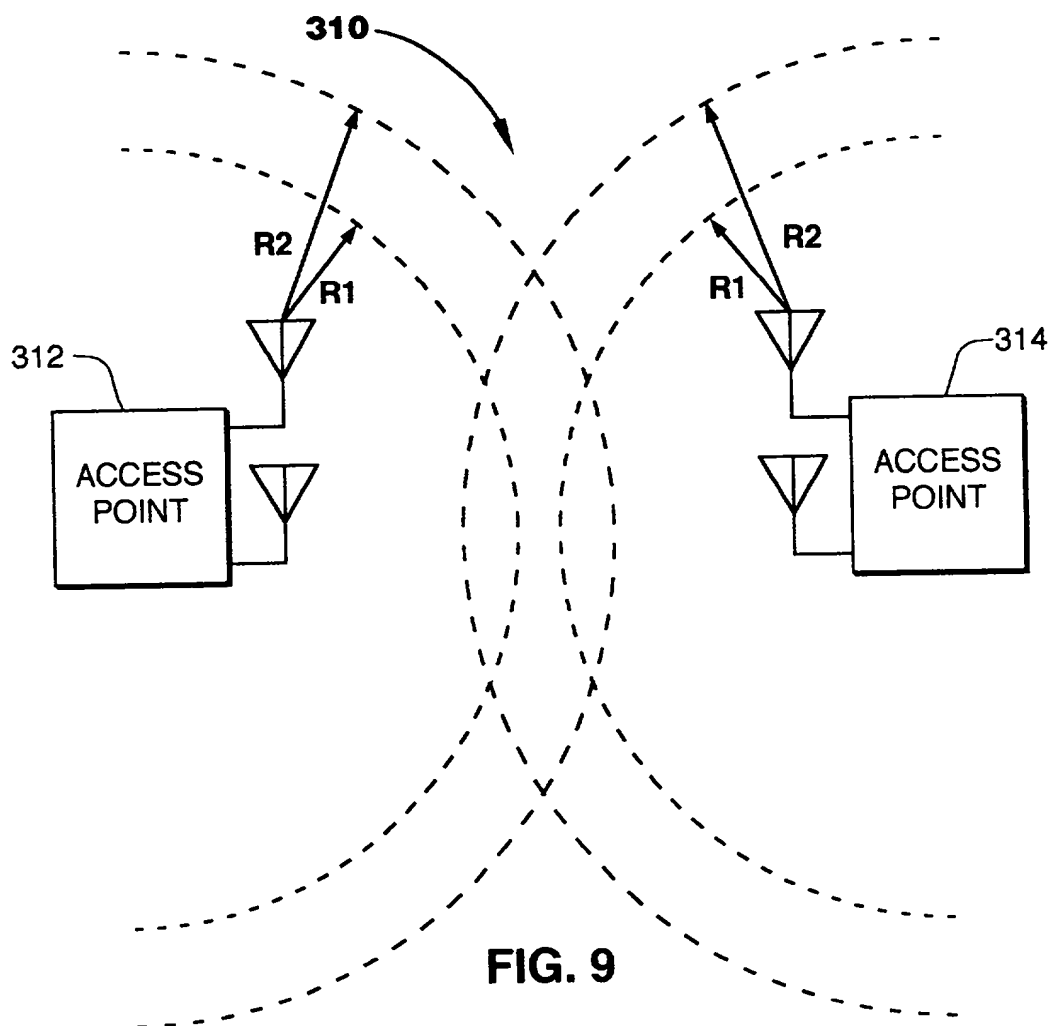
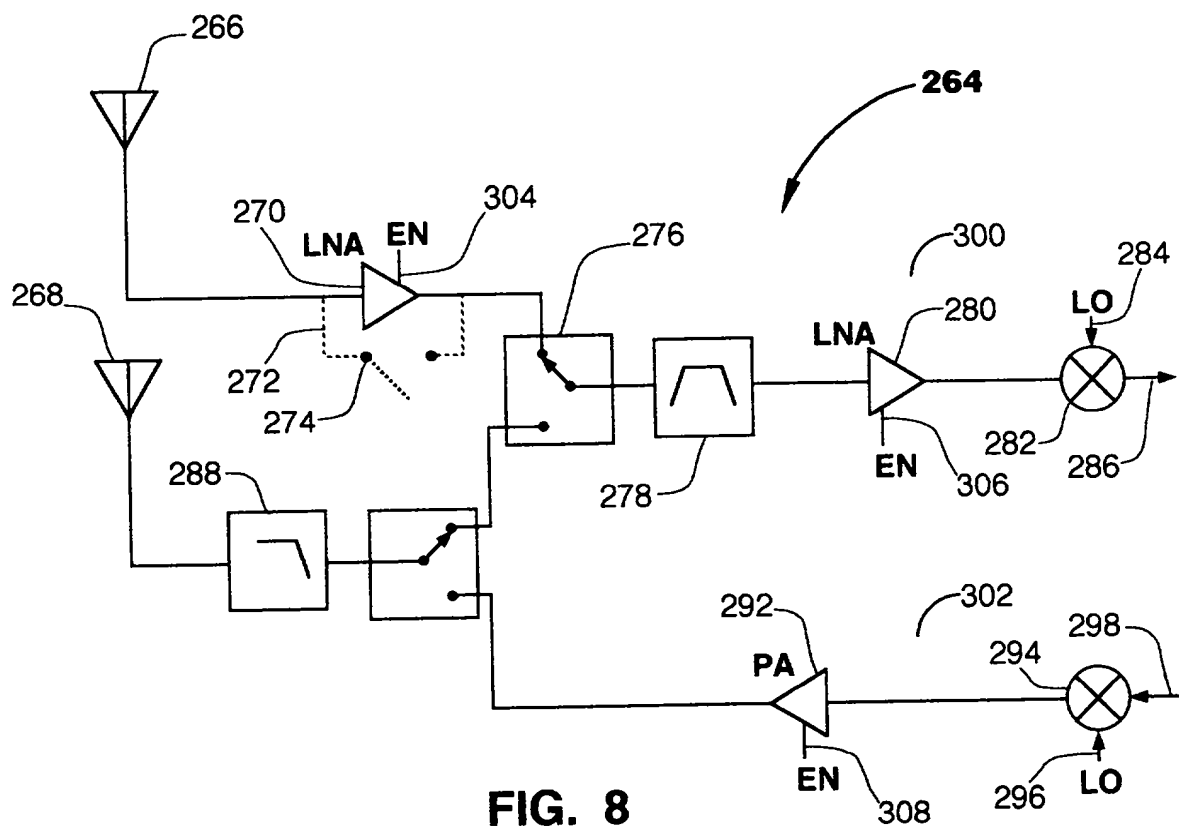


FIG. 7



**COMBINED DECLARATION AND POWER OF
ATTORNEY IN A NONPROVISIONAL PATENT APPLICATION**

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name; that I believe that I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**IMPROVED RECEIVER SENSITIVITY FOR TRANSCEIVER
HAVING DIVERSITY ARCHITECTURE**

described and claimed in the specification as filed on _____ as U.S. Serial N^o _____, via United States Postal Service Express Mail Label N^o EL 025 200 855 US.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 C.F.R. §1.56(a).

**CLAIM FOR BENEFIT OF EARLIER U.S.
APPLICATIONS UNDER 35 U.S.C. §120**

I hereby claim the benefit under 35 U.S.C. §120 of any United States applications that are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in those prior applications in the manner provided by the first paragraph of 35 U.S.C. §112, we acknowledge the duty to disclose information that is material as defined 37 C.F.R. §1.56(a), which occurred between the filing date of the prior applications and the filing date of this application.

USSN

Filing Date

Inventor(s)

Status

N/A

**CLAIM FOR BENEFIT OF EARLIER
APPLICATIONS UNDER 35 U.S.C. §119(e)**

I hereby claim priority benefits under 35 U.S.C. §119(e), of any applications for patent or inventor's certificate listed below:

<u>USPSN</u>	<u>Filing Date</u>	<u>Inventor(s)</u>	<u>Status</u>
60/044,249	04/23/97	Wilz	Provisional

**CLAIM FOR BENEFIT OF EARLIER PCT
APPLICATIONS UNDER 35 U.S.C. §119**

I hereby claim foreign priority benefits under 35 U.S.C. §119, of any foreign applications for patent or inventor's certificate listed below:

<u>PCT Application N°</u>	<u>Filing Date</u>	<u>Country</u>
N/A		

I hereby appoint as my attorneys, with full powers of substitution and revocation, to prosecute this application and to transact all business with the Patent and Trademark Office connected therewith:

William M. Wesley	Reg. N° 26,521
Herbert D. Hart, III	Reg. N° 30,063
Robert W. Fieseler	Reg. N° 31,826
George P. McAndrews	Reg. N° 22,760
John J. Held	Reg. N° 21,061
Timothy J. Malloy	Reg. N° 25,600
J. Michael Jarvis	Reg. N° 27,341
Robert C. Ryan	Reg. N° 29,343
Gregory J. Vogler	Reg. N° 31,313
Donald J. Pochopien	Reg. N° 32,167
Jean Dudek Kuelper	Reg. N° 30,171
Steven J. Hampton	Reg. N° 33,707
Alejandro Menchaco	Reg. N° 34,389
Priscilla F. Gallagher	Reg. N° 32,223
Robert B. Polit	Reg. N° 33,993
George F. Wheeler	Reg. N° 28,766
D. David Hill	Reg. N° 35,543
Christopher C. Winslade	Reg. N° 36,308
Thomas J. Wimbiscus	Reg. N° 36,059
John S. Artz	Reg. N° 36,431
Gregory C. Schodde	Reg. N° 36,668

Edward A. Mas	Reg. N ^o 37,179
Patrick J. Arnold	Reg. N ^o 37,769
Kirk A. Vander Leest	Reg. N ^o 34,036

of MCANDREWS, HELD & MALLOY, LTD., Suite 3400, 500 West Madison Street, Chicago, Illinois 60661.
Telephone (312) 707-8889; and

Sean Patrick Suiter	Reg. N ^o 34,260
Scott C. Rand	Reg. N ^o 40,359
Kenneth J. Cool	Reg. N ^o 40,570

of Omaha, Nebraska; and

Van Metre Lund	Reg. N ^o 16,968
----------------	----------------------------

of North Brook, Illinois; and

James D. Bennett	Reg. N ^o 37,550
------------------	----------------------------

of Austin, Texas; and

Donald R. Schoonover	Reg. N ^o 34,924
----------------------	----------------------------

of Kansas City, Missouri; and

R. Lewis Gable	Reg. N ^o 22,479
----------------	----------------------------

of Washington, D.C.; and

John H. Sherman	Reg. N ^o 16,909
Winfred O.E. Schellin	Reg. N ^o 25,916
Michael F. Williams	Reg. N ^o 39,875

of Cedar Rapids, Iowa.

Please direct all correspondence to:

SEAN PATRICK SUITER
SUITER & ASSOCIATES, PC
11516 Nicholas Street, Suite 205
Omaha, NE 68154-4409
(402) 496-0300 (Telephone)
(402) 496-0333 (Facsimile)

DECLARATION

I hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

The Attorney of Record herein is hereby authorized to insert the Serial Number and filing date when received from the United States Patent and Trademark Office.

Dated: _____

FULL NAME OF INVENTOR:

LEO JOHN WILZ

A Citizen of the United States
1718 Hamer Drive, N.W.
Cedar Rapids, IA 52405
Linn County